To integrate the unknown: touching your lips, hearing your tongue, seeing my voice

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ERC Speech Units

Introduction

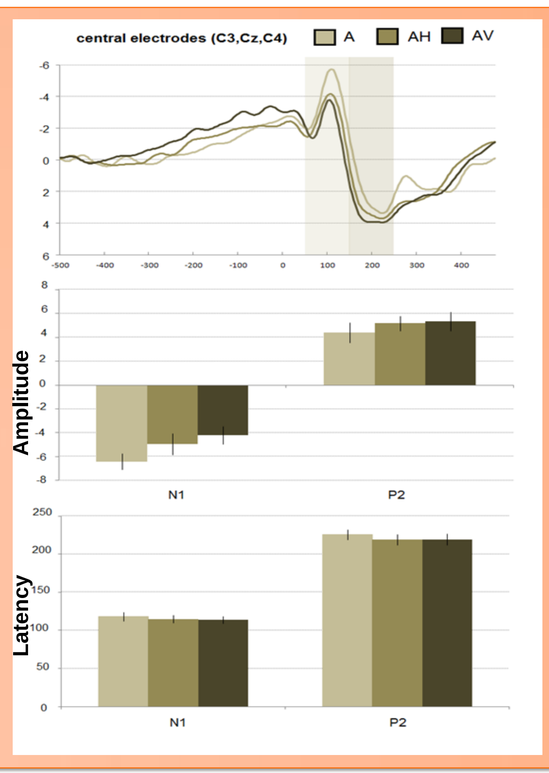
Seeing the speaker's articulatory gestures significantly enhances auditory speech perception. A key issue is whether cross-modal speech interactions only depend on well-known auditory and visual modalities or, rather, might also be triggered by other sensory sources less common in speech communication but likely to exist in the listener's motor knowledge.
The present electro-encephalographic (EEG) and functional magnetic resonance imaging (fMRI) studies investigate cross-modal interactions between auditory, haptic, visuo-facial and visuo-lingual speech signals during the perception of our own productions or/and those of other speakers.

Audio-Haptic : Study 1

EEG : early integration and predictability of speech stimuli during audio-visual (AV; familiar modality) and audio-haptic (AH; unfamiliar modality) perception

Hyp : N1/P2 amplitude reduction and latency facilitation for both AV and AH modalities compared to auditory-only speech

Methods : 16 participants
80 trials per modality and per syllable (/pa/, /ta/, /ka/)
3 conditions : Audio (A), Audio-Visual (AV) & Audio-Haptic (AH)
live dyadic interactions



N1 Amplitude: A>AV=AH
N1 Latency : A>AV=AH
P2 Amplitude : A=AV=AH
P2 Latency : A=AV=AH

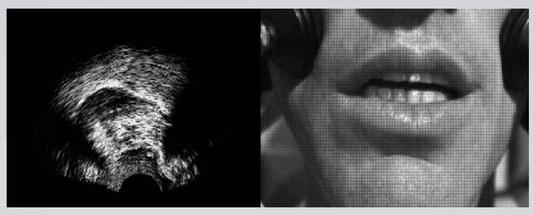
➔Shortened latencies and reduced amplitude of early AEP observed during both audio-visual and audio-haptic speech perception compared to auditory speech perception = **evidence for early multisensorial integrative mechanisms, including haptic modality.**
➔But no difference between /pa/, /ta/ and /ka/ syllables = Amplitude and latency reduction independent on the degree of visual and haptic recognition of the speech targets?

Ref :**Treille et al.(2014a)**. Haptic and visual information speed up the neural processing of auditory speech in live dyadic interactions. Neuropsychologia, 57: 71-77; **Treille et al. (2014b)**. The sound of your lips: electrophysiological cross-modal interactions during hand-to-face and face-to-face speech perception. Frontiers in psychology, 5, Art-420..

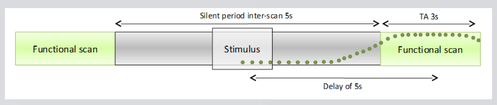
Audio-Visuo-Lingual : Study 2

fMRI : neural correlates of audio-visual-lingual (unfamiliar modality) and audio-visuo-facial (familiar modality) speech perception

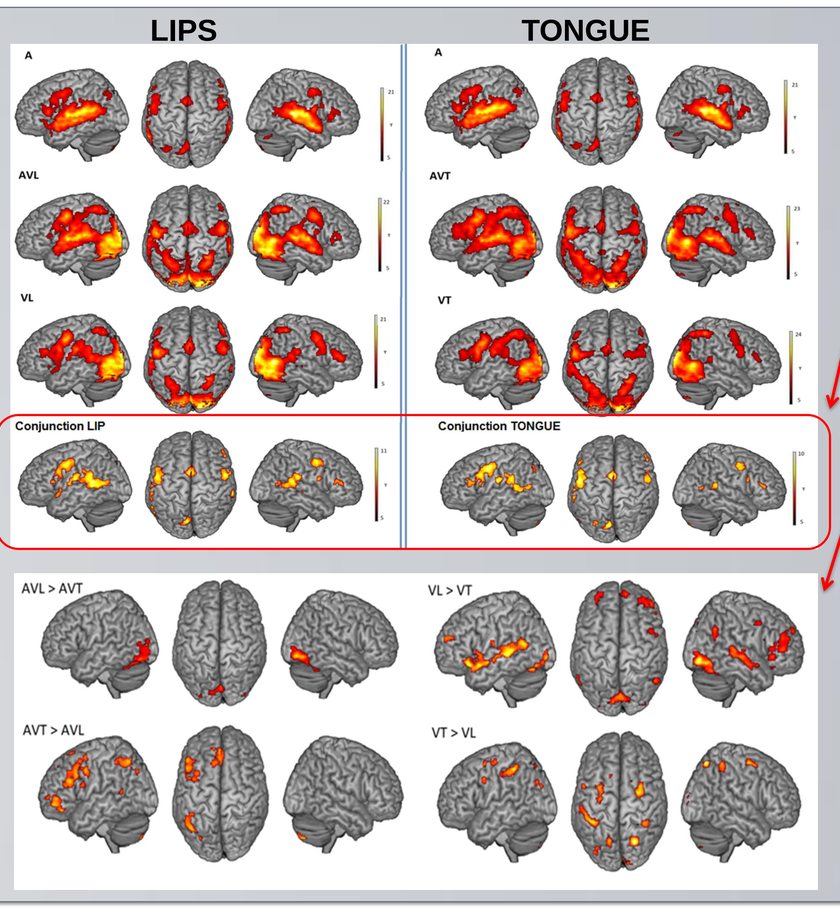
Hyp : natural temporal relationships of visuo-labial and visuo-lingual signals lead to the integration of auditory and visual speech signals



Method : 12 participants
24 trials per modality(/pa/, /ta/, /ka/syllables)
5 conditions: Audio **(A)**, Visual-lips **(VL)**, Visual-tongue **(VT)**, Audio-visual-lips **(AVL)** & Audio-visual-tongue **(AVT)**
passive fMRI session using sparse sampling.



Sparse sampling (1 trial)



Conjunction :
Motor + **pSTS/STG** are activated for all conditions and both lips and tongue movements.

Analysis by modality :
VL≠VT: -*VL* : **auditory** and **visual** cortices.
-*VT* : **motor, premotor** cortices and parts of the sensorimotor cortex.

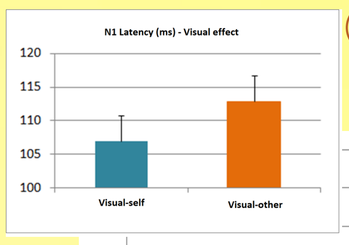
➔ In line with a sensorimotor nature of speech perception, common overlapping activity was observed for both facial and tongue-related speech stimuli in auditory and premotor cortices.

Self-Other : Study 3

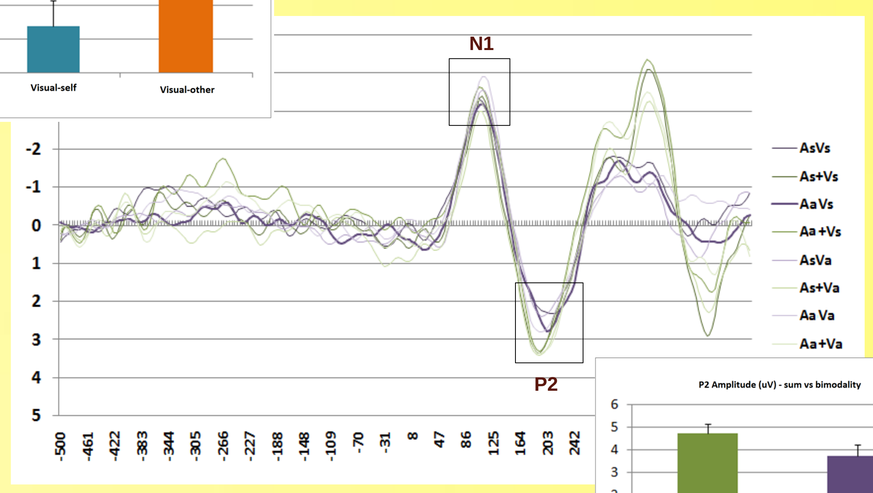
EEG : mechanisms of early integration during the sight and listening of our own productions or those of somebody else

Hyp : modulation of the amplitude and/or latency of N1/P2 related to a possible self-influence during AV integration process

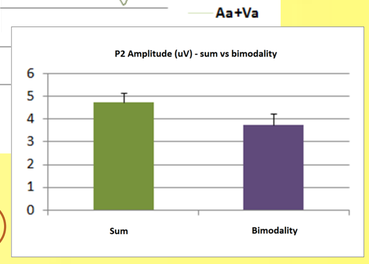
Method : 17 participants
72 trials per modality and speaker (self, other)
4 conditions (Audio **(A)**, Visual **(V)**, Audio-visual **(AV),** AV incongruent **(AVi)**) related to our own speech gestures or those of somebody else.



B



A



A: **P2 Amplitude**
AV < A + V

B: **N1 latency**
visual-self < visual-other

➔ A self-advantage was observed with shortened latencies of early AEPs for self-related audio-visual speech stimuli.

Conclusion

Altogether our results provide evidence for multisensorial interactions between auditory speech signals and their haptic, visuo-facial or visuo-lingual speech correlates. They further emphasize the multimodal nature of speech perception and demonstrate that multisensory speech perception is partly driven by sensory predictability and by the listener's knowledge of speech production.

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